Photonic crystal sensor with micro flow channels

K. Okamoto, M. Sugita, Y. Nagatomo, J. Yamamichi, T. Yamazaki, and M. Uchida
Leading-Edge Fusion Research Center., Canon Inc.
Ohta-ku Tokyo 146-8501 Japan, E-mail:Okamoto.kohei@canon.co.jp

Sensor applications of photonic crystals(PCs) have drawn much attention[1][2] because of high sensitivity and suitability for μ-TAS(Total Analysis System)s. Here, we demonstrate a great capability of PCs for Refractive-Index-Sensor(Index-Sensor) and Bio-Sensor applications.

Sensing is performed by measuring the wavelength shift of the photonic-band-edge(PBE) due to the change of refractive-index distribution inside and around the PC caused by the introduction or the adsorption of material. Since the change of transmittance at the PBE is extremely sharp, a high sensitivity is expected.

The device consists of two 10μm-wide waveguides and a 10μm-long two-dimensional PC region of triangular-lattice of air-holes fabricated on an SOI(Silicon On Insulator) wafer with a 200nm-thick SOI-layer. The first PBE in Γ-K direction of TE mode was used for the measurement. To introduce fluid specimen into the PC region, we adopted a technique using micro flow channels made of PDMS(polydimethylsiloxane) [Fig.1].

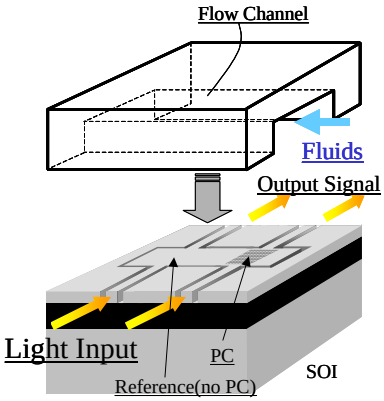

Fig.1 Schematic of device

In the Index-Sensor experiment we measured PBE-shift($\Delta\lambda$)s for water, ethanol and isopropanol(IPA) compared with air[Fig.2]. Considering the two models : Model1(holes filled up with fluid) and Model2(empty holes), even after the introduction of the fluids, holes are not completely filled with each fluid but to the same degree.

For the Bio-Sensor demonstration BSA(Bovine Serum Albumin) labeled with fluorescein was used as analyte protein which is dissolved in PBS(Phosphate Buffered Saline) solution. We have measured $\Delta\lambda \sim$ 0.3nm due to the adsorption of the protein replacing PBS background and $\Delta\lambda \sim$3.3nm for the air background. The experiment and an analytical study lead that the refractive index contrast to the background medium highly influences the sensitivity. Based on the results, we estimated the sensitivity of the PC sensor.

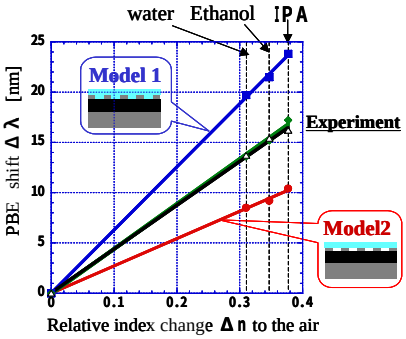

Fig.2 PBE shift for the refractive-index change

In conclusion, by experiment with micro flow-channels, modeling, and quantitative analysis, the first demonstration of PC's possibility for Refractive-Index-Sensor and Bio-Sensor applications has been done.

References : [1] M. Lončar, et al., Appl. Phys. Lett., 82(2003), 4648
[2] E. Chow, et al., Opt. Lett., 29(2004), 1093